

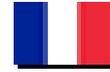
# Hydrogeology of Algeria

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Algeria is the largest country in Africa, with an economy dominated by petroleum products, a sizeable military, and considerable regional influence. Agriculture, supported by irrigation, makes up a small part of the economy. Most people live on the north, Mediterranean, coast. The Saharan desert, which covers the south of the country, is sparsely populated. Over 80% of both the rural and urban population are classed as having access to safe drinking water.

Water supply is heavily dependent on groundwater, for drinking, agriculture and industry. Agriculture in the north of Algeria relies on groundwater irrigation, from relatively young and shallow coastal aquifers, which are actively recharged by rainfall. In the south, deep sedimentary aquifers contain vast quantities of 'fossil' groundwater, which is not being actively recharged. Groundwater from these deep aquifers has been used traditionally for centuries, at relatively small scale, through *foggaras* - water galleries, and there are also larger modern abstractions. Groundwater level decline in some areas shows that some over-exploitation is taking place.

Groundwater abstraction is promoted by subsidies, which make it relatively cheap to use, and discourage water conservation. However, water subsidies are underpinned by revenue from oil and gas, and are threatened by falling world hydrocarbon prices. To protect its hydrocarbon revenues, the Algerian government has proposed developing its large shale gas resources, using hydraulic fracturing, which has met with concern relating to potential groundwater pollution, particularly related to 'fossil' groundwater, which is irreplaceable. Aquifer pollution has occurred in some areas, for example saline intrusion along the coast relating to over-abstraction, and nitrate pollution from agriculture, despite legislation to limit nitrate contamination pollution from agricultural activities.

□

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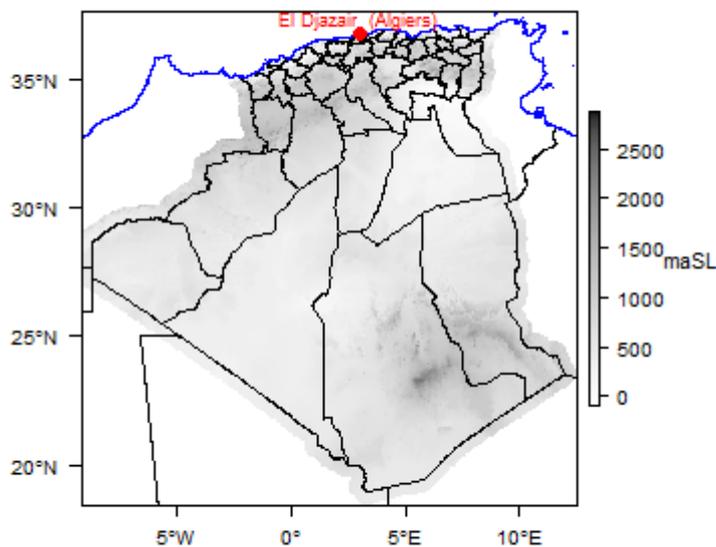
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## Geographical setting



Algeria. Map developed from USGS GTOPOPO30; GADM global administrative areas; and UN Revision of World Urbanization Prospects. For more information on the datasets used to develop the map see the [geography resource page](#)

## General

The northern coastal area of Algeria is hilly, sometimes mountainous, with a fertile plain between the coast and the 1 500 km-long Tell and Saharan Atlas mountain chains that run parallel to the coast. To the south of the Atlas mountains is the larger part of Algeria's land surface, which is dominated by the Sahara Desert.

Capital city	Algiers
Region	North Africa
Border countries	Tunisia, Libya, Niger, Mali, Mauritania, Morocco
Total surface area *	2,381,740 km <sup>2</sup> (238,174,000 ha)

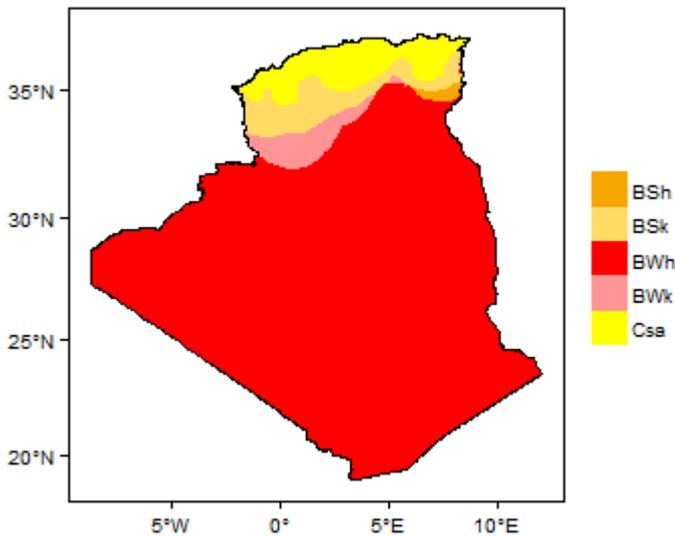
Total population (2015)*	39,667,000
Rural population (2015)*	10,928,000 (28% of total)
Urban population (2015)*	28,739,000 (72% of total)
UN Human Development Index (HDI) [highest = 1] (2014)*	0.7356

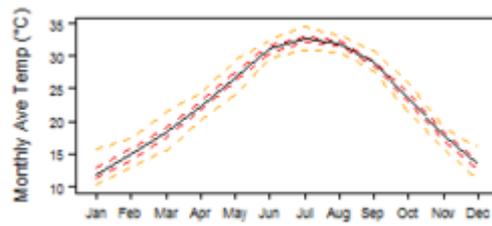
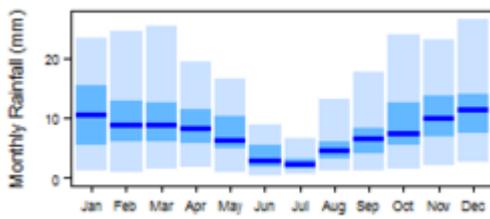
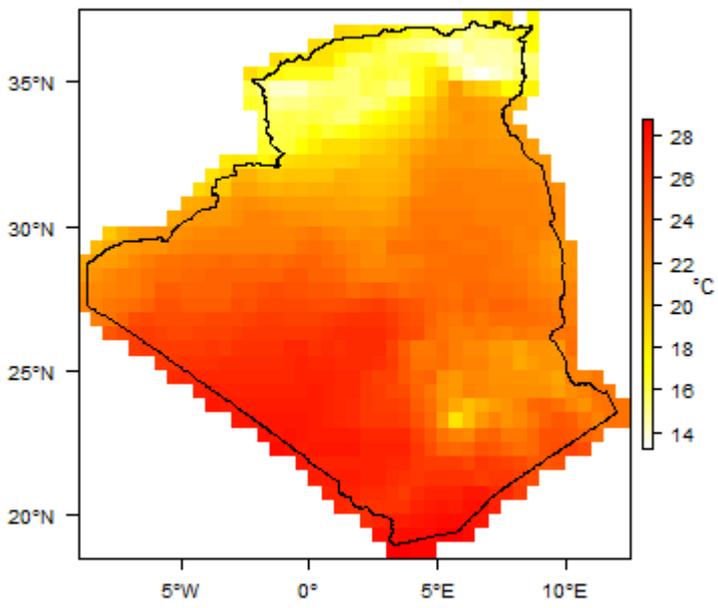
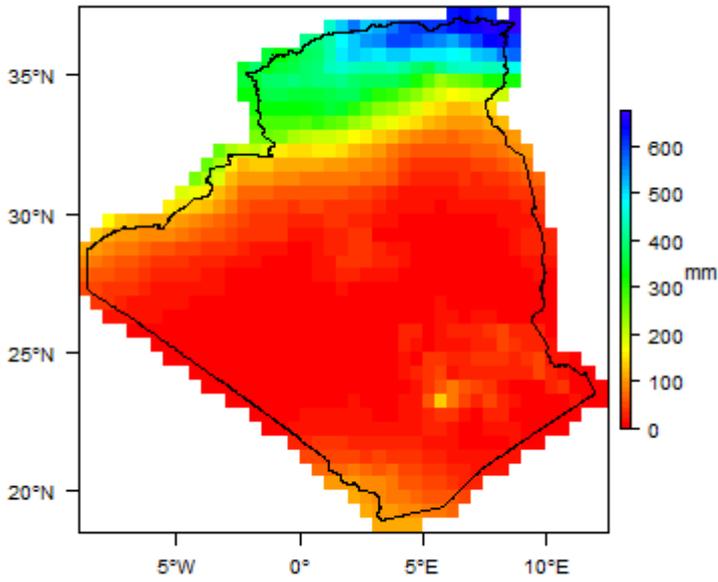
\* Source: [FAO Aquastat](#)

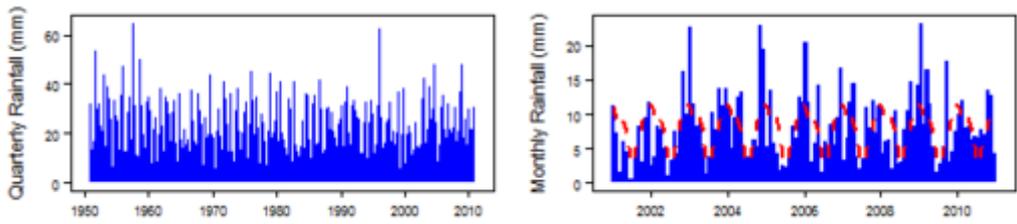
## Climate

The climate of Algeria's northern coastal region is temperate, with dry, hot summers and mild, wet winters. Average annual precipitation in the coastal region is around 600 mm, ranging up to 1800 mm in the east. The climate in the south of Algeria is arid, with average annual rainfall less than 100 mm, and sometimes close to zero. Rainfall in this area is usually concentrated in rare, short events. Average temperatures generally increase from north to south, although values are slightly higher in the coastal region compared to the Atlas mountains, because of the cooling effect of elevation.

There are temporal changes in precipitation and temperature throughout the year. The hottest months of June, July and August generally correspond to a distinct dry season.







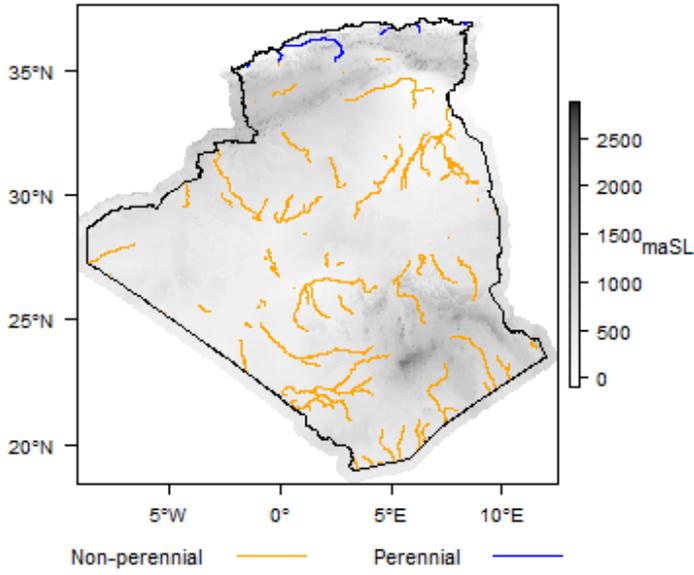
More information on average rainfall and temperature for each of the climate zones in Algeria can be seen on the [Algeria climate page](#).

These maps and graphs were developed from the CRU TS 3.21 dataset produced by the Climatic Research Unit at the University of East Anglia, UK. For more information see the [climate resource page](#).

**Surface water**

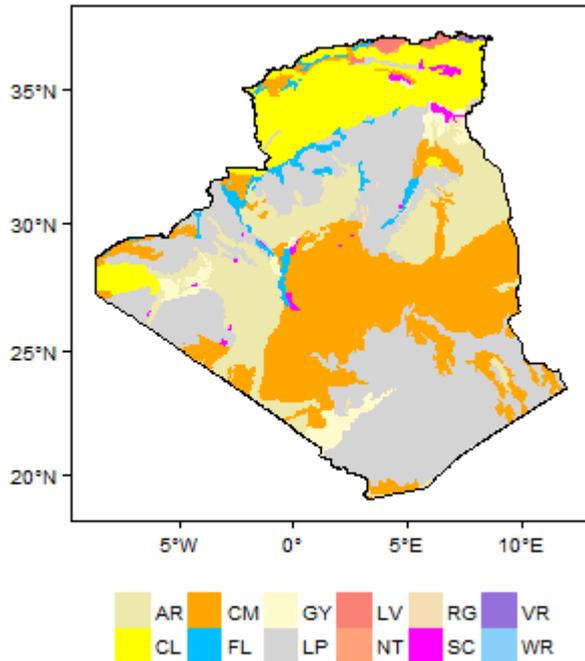
There are 17 major watersheds in Algeria. Low rainfall means that the majority of rivers in the mountainous and desert regions of Algeria are ephemeral, flowing only after large rainfall events. Only the rivers in the northern coastal region are perennial, flowing all year round. In the south, wadis (ephemeral rivers) drain to closed internal sinks - *chotts* or *sebkas* - which are subject to high evaporation rates. The Chelif (or Cheliff) River is the longest river in Algeria, flowing for 700 km from its source in the Saharan Atlas to its discharge point in the Mediterranean Sea. The Agence Nationale des Ressources Hydrauliques (ANRH) is responsible for river-flow gauging in Algeria. ANRH maintains a network of 162 hydrometric stations, almost exclusively in the north of the country, and collects hydrometric data on average monthly flow rates or average monthly inflows to hydrological stations. These data are typically available for periods of between 25 and 30 years (www.anrh.dz)

In some watersheds at large dams, hydrometric measurements are made by the National Agency of Dams and Transfers (ANBT).



Major surface water features of Algeria. Map developed from World Wildlife Fund HydroSHEDS; Digital Chart of the World drainage; and FAO Inland Water Bodies. For more information on the map development and datasets see the [surface water resource page](#)

## Soil

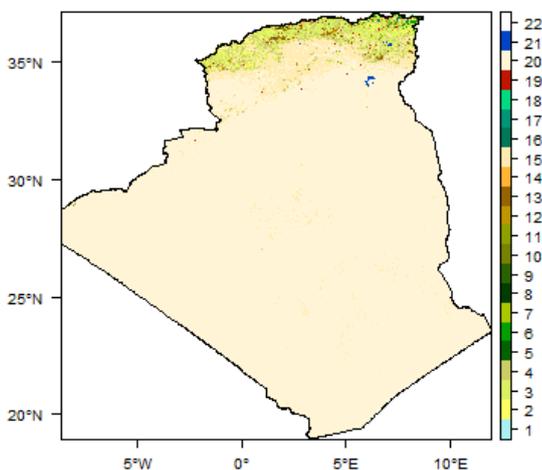


Soil map of Algeria, from the European Commission Joint Research Centre: European Soil Portal. For more information on the map see the [soil resource page](#)

Soils in the mountainous Atlas region of Algeria are dominated by stony leptosols. In the drier area to the north of the Atlas, soils are generally rich in calcium carbonate (calcisols). Many of these soils are suitable for agriculture, but water availability is a key constraint on crop growth. Along the wetter coastal region, soils are better developed and give rise to more vegetation - these include luvisols and cambisols. Vertisols, which support extensive cereal cultivation and grazing, occur in the eastern coastal region of Algeria. The arid region to the south of the Atlas is characterised by poorly developed leptosols, which contain little organic matter. Regions of arenosols denote large areas of sand dunes.

Fluvisols are found along river valleys. To the south of the Atlas the rivers are generally ephemeral, but in the wetter northern region, where rivers are more or less perennial, the valleys are often intensively cultivated.

## Land cover



Land cover map of Algeria, from the European Space Agency GlobCover 2.3, 2009. For more information on the map see the [land cover resource page](#)

## Water statistics

	2001	2012	2014	2015
Rural population with access to safe drinking water (%)			81.8	
Urban population with access to safe drinking water (%)			84.3	
Population affected by water related disease	No data	No data	No data	No data
Total internal renewable water resources (cubic metres/inhabitant/year)			283.6	
Total exploitable water resources (Million cubic metres/year)		7,900		
Freshwater withdrawal as % of total renewable water resources		66.92		
Total renewable groundwater (Million cubic metres/year)			1,517	
Exploitable: Regular renewable groundwater (Million cubic metres/year)		1,900		
Groundwater produced internally (Million cubic metres/year)			1,487	
Fresh groundwater withdrawal (primary and secondary) (Million cubic metres/year)		3,000		
Groundwater: entering the country (total) (Million cubic metres/year)			30	
Groundwater: leaving the country to other countries (total) (Million cubic metres/year)			100	
Industrial water withdrawal (all water sources) (Million cubic metres/year)		415		
Municipal water withdrawal (all water sources) (Million cubic metres/year)		3,020		
Agricultural water withdrawal (all water sources) (Million cubic metres/year)		4,990		
Irrigation water withdrawal (all water sources) <sup>1</sup> (Million cubic metres/year)	3,502			
Irrigation water requirement (all water sources) <sup>1</sup> (Million cubic metres/year)	2,511			
Area of permanent crops (ha)			969,800	
Cultivated land (arable and permanent crops) (ha)			8,439,000	
Total area of country cultivated (%)			3.5	
Area equipped for irrigation by groundwater (ha)		841,600		
Area equipped for irrigation by mixed surface water and groundwater (ha)		14,200		

These statistics are sourced from [FAO Aquastat](#). More information on the derivation and interpretation of these statistics can be seen on the FAO Aquastat website.

Further water and related statistics can be accessed at the [Aquastat Main Database](#).

<sup>1</sup> More information on [irrigation water use and requirement statistics](#)

## Geology

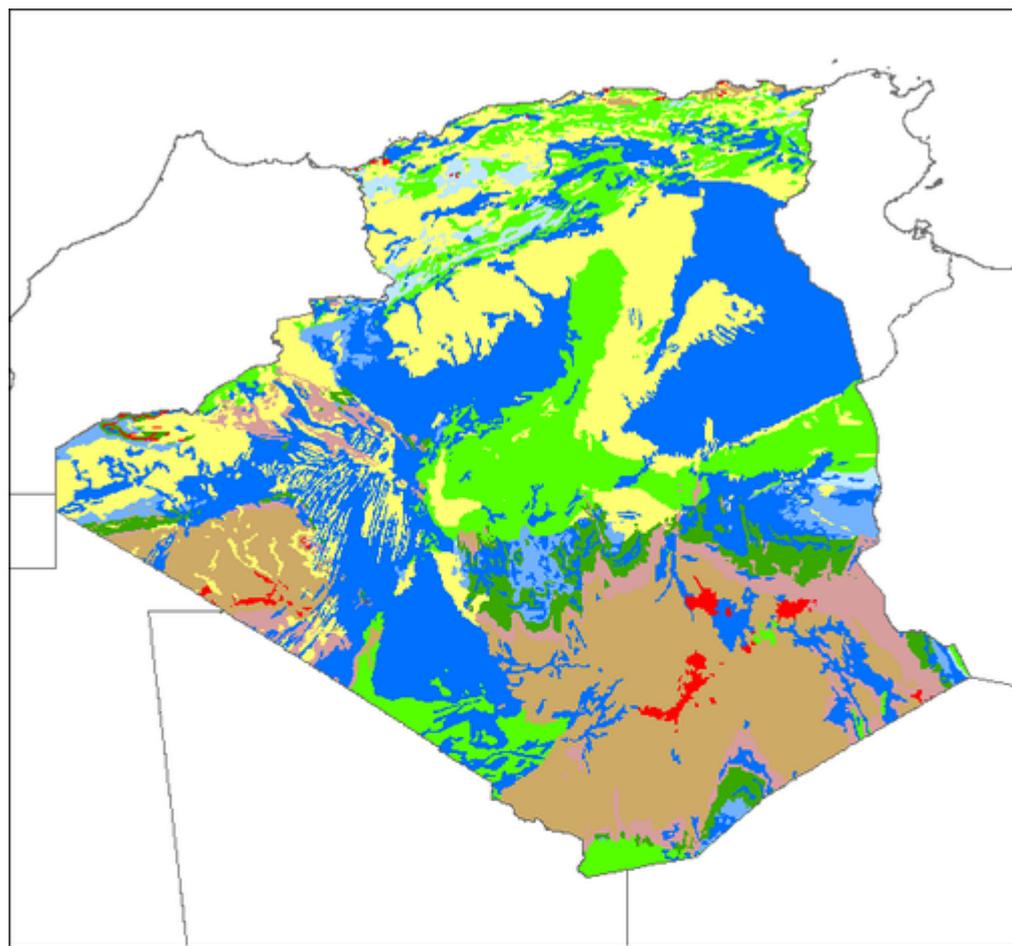
This section provides a summary of the geology of Algeria. More detail can be found in the references listed at the bottom of this page. Many of these references can be accessed through the

[Africa Groundwater Literature Archive.](#)

The geology map on this page shows a simplified overview of the geology at a national scale (see the [Geology resources section](#) for more details).

[Download a GIS shapefile of the Algeria geology and hydrogeology map.](#)

Other, larger scale, geological maps are available: for more details see the Key geology references section below.



### Algeria - Geology

- Recent-Quaternary unconsolidated sediments
- Cenozoic marine sedimentary
- Cenozoic Volcanic
- Cretaceous sedimentary
- Triassic to Jurassic sedimentary
- Carboniferous sedimentary
- Devonian sedimentary
- Cambrian to Silurian sedimentary
- Precambrian, undifferentiated

Geology of Algeria at 1:5 million scale. Based on map described by Persits

et al. 2002 / Furon and Lombard 1964. For more information on the map development and datasets see the [geology resource page](#). [Download a GIS shapefile of the Algeria geology and hydrogeology map](#).

## Summary

Algeria is divided into two major tectonic units, separated by the South Atlas fault:

- the **Northern (Atlas) domain**, which has been strongly affected by Alpine tectonics
- the **Southern (Saharan) domain**, which is relatively stable and where the impact of tectonics is less pronounced.

The **northern (Atlas) domain** is defined by the following west-east-trending geological features:

- in the southern part, the Saharan Atlas mountain range of alpine origin
- in the centre, platforms, including Oran Meseta to the west and the Mole Ain Regada in the east
- in the northern part, the Tell Atlas, a complex area composed of tectonic layers stacked up during the Miocene. Late Neogene sedimentary basins, such as the Chelif Hodna, formed on these Miocene tectonic sheets.

The **southern (Saharan) domain** lies to the south of the Atlas mountains and belongs to the North African Craton. Precambrian basement is unconformably overlain in much of this domain by thick sedimentary rock of Palaeozoic to Mesozoic age, which have formed in several basins separated by high ground.

Key Formations	Period	Geological environments	
		Lithology	Structure
		<b>Unconsolidated sediments</b>	
	Recent-Quaternary	These unconsolidated sediments include sabkha and lake deposits; fluvial and recent alluvial deposits, often deposited in intramontane grabens; and dune deposits. Intramontane alluvial deposits are typically highly heterogenous: for example, sometimes almost isolated gravel lenses within a dominantly silt sequence.	Many alluvial sediments were deposited in intramontane grabens, overlying generally carbonate bedrock.
		<b>Cenozoic</b>	
Marine sedimentary	Neogene-Palaeogene	Marine sandstones and limestones	
Volcanic	Plio-Quaternary (occasionally Cretaceous)	Rocks formed by recent volcanism: in the north-west (Ain Témouchent) and north-east (Béjaia and Jijel).	
		<b>Mesozoic sedimentary</b>	

Cretaceous	<p>Mainly marine sedimentary rocks. In the <b>northern (Atlas) domain</b>, these include:</p> <ul style="list-style-type: none"> <li>- Late Cretaceous (Senonian) marly limestones marking deeper marine sedimentation</li> <li>- Turonian marl, which is extensive in the north, except for highland areas and Constantine</li> <li>- Cenomanian marine deposits. These include shallow evaporites in the south; deeper marine in the Tell area, where there is 1000 m thickness of pelagic marl; neritic carbonate in Hodna</li> <li>- Albian sandstones and flysch deposits in the Atlas; and clay-sand facies in the Tell region</li> <li>- Aptian carbonate reef transgression sedimentary rocks in the Hodna and Aures areas</li> <li>- detrital and silicious rocks that crop out in the Atlas mountains.</li> </ul>	<p>Occur in elongate basins in the Atlas domain, and very large basins in the Sahara domain; e.g. the dorsale du M'Zab in the central Sahara, and Monts d'Ougarta, Daoura Basin, Tademait Plateau and Tinherit Plateau in north-occidental Sahara. The Continental Intercalaire covers a total area (not only in Algeria) of approximately 600,000 km<sup>2</sup>.</p>
	<p>In the <b>southern (Sahara) domain</b>, these include:</p> <ul style="list-style-type: none"> <li>- the Complexe Terminal: marine limestones and sandstones with interlayered terrestrial sandy and clayey formations, and some evaporates, of Late Cretaceous to Miocene and Pliocene age</li> <li>- the Continental Intercalaire, of Early Cretaceous age: largely terrestrial siliciclastic clayey sandstones with some marine Aptian limestones and clay formations. Reaches up to 2000 m thick (Castany, 1981) and occurs at depths ranging from around 400 to 2000 m below ground (Schmidt, 2008).</li> </ul>	

Triassic (sometimes Permo-Triassic) to Jurassic	<p>Triassic and Jurassic rocks are not widespread in Algeria; they occur mainly in the Atlas domain. The oldest Triassic rocks are 'Karoo'-type red sandstones, limestones and claystones, e.g. in Great Kabylia. These pass upwards to evaporites and to Mushelkalk limestone. Towards the south of the Atlas domain, Triassic rocks are evaporitic and gypsiferous, underlain by Mushelkalk limestone. In the northern Atlas domain, the Jurassic sequence starts with a marine transgression and includes dolomitic limestone, passing upwards to marl in the Upper Lias. In the southern Sahara domain, the Jurassic is largely continental, with shales, mudstones, siltstones and conglomerates.</p>	Occur mainly in the Atlas domain, in a series of basins in conjunction with younger Cretaceous and Cenozoic sedimentary rocks.
<b>Palaeozoic sedimentary</b>		
Cambrian (occasionally Precambrian) to Carboniferous	<p>Mainly marine, clastic and carbonate sedimentary rocks, which can reach several kilometres in thickness. Includes sandstones and dolomitic limestones. Affected by the Hercynian Orogeny. In the <b>northern (Atlas) domain</b>, these include:</p> <ul style="list-style-type: none"> <li>- Ordovician to Silurian metasedimentary rocks</li> </ul> <p>In the <b>southern (Sahara) domain</b>, these include:</p> <ul style="list-style-type: none"> <li>- Carboniferous continental sedimentary rocks</li> <li>- Early Carboniferous and Devonian marine sedimentary rocks</li> <li>- Silurian shales and limestones, with graptolites</li> <li>- Cambro-Ordovician sandstones</li> </ul>	Formed in sedimentary basins separated by high ground.
<b>Precambrian</b>		
Proterozoic	<p>The Ougarta chain in south-west Algeria was affected by north-west to south-east and east to west folding during the Hercynian Orogeny (Donzeau, 1972).</p>	
Archaean	<p>Plutonic and gneissose complex, often migmatites, in the east of Hoggar and Reguibat areas in south-east Algeria; undifferentiated metamorphic rocks elsewhere.</p>	

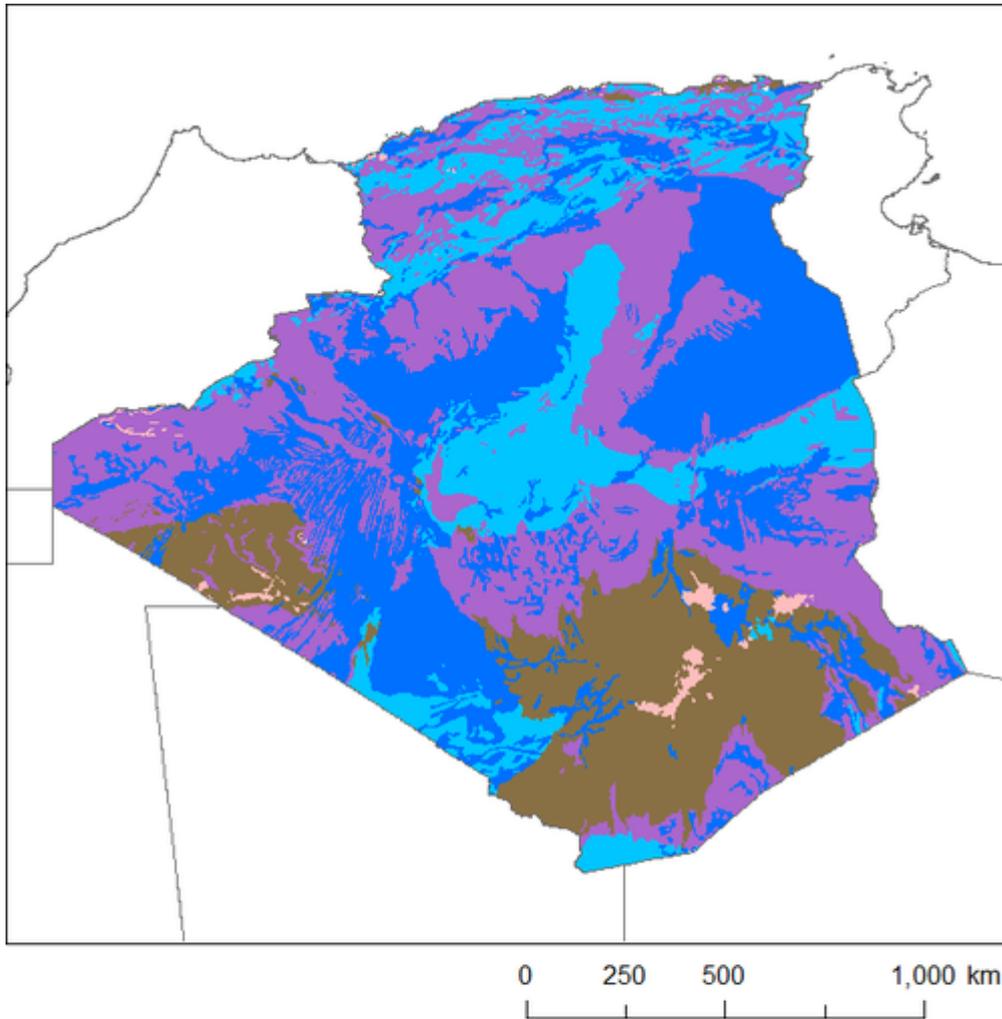
# Hydrogeology

This section provides a summary of the hydrogeology of the main aquifers in Algeria. More information is available in the references listed at the bottom of this page. Many of these references can be accessed through the [Africa Groundwater Literature Archive](#).

The hydrogeology map on this page shows a simplified overview of the type and productivity of the main aquifers at a national scale (see the [Hydrogeology map resource page](#) for more details).

**[Download a GIS shapefile of the Algeria geology and hydrogeology map.](#)**

Other hydrogeological maps are available, including the *Carte des aquiferes de l'Algérie* (ANRH, 2003) at 1:4.5 million scale; the *Carte hydrogéologique de l'Afrique a l'échelle du 1:10 million* (BRGM, 2008) and, for north Algeria, a hydrogeological map at 1:3 million scale and a series of maps at 1:200 000 scale (ANRH/Energoprojekt, 2009). See the Key hydrogeology references section below for more details.



### Algeria - Aquifer Type and Productivity

- Unconsolidated - High permeability; resource depends on recharge
- Sedimentary Intergranular/Fracture - Moderate to High
- Sedimentary Intergranular/Fracture/Karst - High to Very High
- Volcanic - Low
- Basement - Low

Hydrogeology of Algeria at 1:5 million scale. For more information on how the map was developed see the [hydrogeology map resource page](#).

[Download a GIS shapefile of the Algeria geology and hydrogeology map.](#)

### Summary

#### *Northern (Atlas) domain*

The complex tectonic history has segmented the main Mesozoic to Cenozoic sedimentary geological units, resulting in a large number of relatively small, spatially limited, compartmentalised aquifer units. There are three main aquifer types: (1) unconsolidated Cenozoic and Recent-Quaternary sedimentary aquifers in the coastal plain; (2) Mesozoic-Cenozoic sandstone and limestone aquifers in the mountainous areas; and (3) alluvial aquifers in river valleys. At a regional level, significant aquifers are highly fragmented. The most important aquifers are the Hodna and Chott Chergui of the

Saharan Atlas, and the Mitidja and Annaba-Bouteldja coastal aquifer.

*Southern (Sahara) domain*

This zone covers more than 80% of the country, and includes the Northern Saharan Aquifer System (SASS), comprising the lower Continental Intercalaire and the upper Complexe Terminal, which forms one of the world's largest aquifers. The groundwater in this aquifer is generally considered to be 'fossil' water (Moulla et al., 2012; OSS, 2003), and because of the very low rainfall in the Sahara (<100 mm/year), active recharge to these aquifers is extremely low. The exploitation of groundwater resources of the Sahara is therefore groundwater 'mining', with inexorable decline in available resources.

**Unconsolidated sediments: Recent-Quaternary to Cenozoic**

Named aquifers	General description	Water quantity issues	Water quality issues	Recharge
Coastal plain sediments	Coastal dunes are sandy deposits with highly variable thickness and lateral extent, usually ranging from 5 to 10 m thick, but up to 150 m thick, e.g. at Bouteldja. Average permeability is $10^{-4}$ to $10^{-8}$ m/s and average transmissivity is $10^{-2}$ to $10^{-3}$ m <sup>2</sup> /s. Storativity can be ~10%. The water table depth is typically 1 to 10 m.		Water quality is generally good, but the high aquifer permeability means groundwater is vulnerable to pollution, and in particular to saline intrusion.	Most recharge is from direct rainfall infiltration. There is active annual recharge.
Alluvium deposits	Intramontane alluvial (wadi) deposits form complex, multilayered aquifer systems, characterised by strong vertical and horizontal anisotropy. Groundwater sometimes exists in almost isolated gravel lenses within dominantly low permeability silt. Average thickness of alluvial deposits at Djanet is 15 m. Isolated gravel layers can be confined, but otherwise the aquifers are largely unconfined. Average permeability is $10^{-4}$ to $10^{-8}$ m/s and average transmissivity is $10^{-2}$ to $10$ m <sup>2</sup> /s. Storativity can be ~10%. Yields at Hoggar vary from 15 to 63 l/s. The water table depth is typically 1 to 10 m.		Water quality is generally good, but the high aquifer permeability means groundwater is vulnerable to pollution.	Some recharge is from direct rainfall infiltration. In Hoggar and Djanet, recharge occurs mainly during floods. Where the aquifers overlie karstic aquifers, recharge can occur by upward flow from these aquifers.

## Igneous

Named aquifers	General description	Water quantity issues	Water quality issues	Recharge
	Igneous aquifers exist in Zaccae, Djurdjura, Collo and l'Edough in the east, and in Hoggar. Groundwater flows through fractures and altered horizons, and discharges naturally through springs. In Hoggar, borehole drilling has shown that groundwater is encountered at between 20 and 50 m depth. The aquifers generally have low productivity.		Average total dissolved solids in Hoggar are 500 mg/l.	Important recharge occurs in northern igneous aquifers.

## Sedimentary - intergranular and fracture flow

Named aquifers	General description	Water quantity issues	Water quality issues	Recharge
Cenozoic sandstones and limestones	Semi-consolidated marine sedimentary rocks with relatively high porosity in which groundwater is stored and flows through both intergranular matrix and fractures.			
<b>Northern (Atlas) domain:</b> Jurassic and Cretaceous limestones	Consolidated marine sedimentary rocks with relatively high karstic porosity, in which groundwater is stored and flows dominantly through fractures and karst conduits. This is often a highly productive aquifer. Yields of more than 100 l/s are seen from the Zibans karst; and greater than this from the Neritic formation of Constantine (900 l/s at Hamma springs; 400 l/s at Fourchi; 650 l/s at Boumerzoug). In some parts there is extensive groundwater discharge via springs, e.g. at Zaccar (Miliana sources), Djurdjura, and its extension to Bejaia.		Thermal waters. The groundwaters are generally of calcium bicarbonate or calcium sulphate type.	Direct recharge, mostly occurring during periods of exceptionally heavy rain. Some recharge by horizontal flow from other aquifers.

<p><b>Southern (Saharan) domain:</b> Complexe Terminal (Late Cretaceous to Cenozoic) and Continental Intercalaire (Palaeozoic to Late Cretaceous)</p>	<p>These two aquifers together form part of the transboundary Northern Saharan Aquifer System (SASS), also known as the North-west Sahara Aquifer System (NWSAS) (see section on Transboundary aquifers, below). These are largely deeply buried, and can be at least 2000 m thick. Much of the aquifer is siliclastic sandstone; some parts are karstic; and there are some evaporates. This is often a highly productive aquifer. Analysis of pumping tests in the Continental Intercalaire in the Adrar region suggests hydraulic conductivity values of between <math>3 \times 10^{-4}</math> and <math>3 \times 10^{-5}</math> m/s. In some parts there is groundwater discharge via springs; in other areas there are no identified outflows, e.g. the Setifian in the south. The Continental Intercalaire has been exploited for centuries around its edges in the Sahara by foggaras (water galleries). Found in the south of Algeria in relatively small areas, in Hoggar and Tassili. They have high porosity. Exploited at Djanet by boreholes with an average depth of 400 m. Borehole yields are 20 to 30 l/s at Djanet, and 5 l/s at Tassilis.</p>	<p>The groundwater resource is generally considered to be 'fossil' - many thousands of years old - and in areas is known to be overexploited, with groundwater level decline (Moulla, 2012).</p>	<p>Water quality ranges from good, with relatively low levels of mineralisation, to poor. In some areas, groundwater in the Complexe Terminal has salinity levels between 4 and 9 g/l (FAO, 2009). Groundwater from the Continental Intercalaire can be hot - between 45 and 65°C.</p>	<p>Recharge is minimal, due to the generally deep burial of the aquifers and the arid climate. Small amounts of recharge occur from episodic rainfall where the aquifers crop out at the ground surface.</p>
<p>Cambrian to Devonian sandstones</p>				

Key references for these aquifers are: ABH, 2009; Chabour, 2006; Djebbar, 2005; Ferraga, 1986; ISSAADI, 1981; Moulla et al., 2012; Schmidt, 2008; and Souag, 1985 (see Reference section, below).

### Basement

Named aquifers	General description	Water quantity issues	Water quality issues	Recharge
	<p>Weathering of basement rocks creates enhanced permeability and local aquifers of limited spatial extent, capable of supplying small yields from shallow wells.</p>			<p>Recharge is small, occurring during episodic rainfall events.</p>

### Groundwater status

## **Groundwater quantity**

The potential for available exploitable groundwater has been estimated for 123 different hydrogeological units by the Agence Nationale des Ressources Hydrauliques (ANRH). The total available exploitable groundwater potential is estimated at about 2.7 billion m<sup>3</sup> in the northern Atlas region and 5 billion m<sup>3</sup> in the southern Saharan region.

Some aquifers located downstream of dams are deprived of recharge.

## **Groundwater quality**

The ABH's Plan National de l'Eau, Mission 5, was aimed at increasing knowledge on water quality. Analyses of water quality focused on selected physico-chemical elements, including temperature, conductivity, chloride and sulphate, and on organic and mineral pollutants including nitrogen and phosphorous. The results showed that groundwaters are often hard, with high conductivity and high levels of mineralisation, in particular sulphate. The high conductivity, or salinity, is influenced in some places by aquifer lithology and mineralogy, but also by rainfall and high evaporation in arid and semi-arid zones, and in some cases by aquifer overexploitation. Some coastal aquifers have been intruded by sea water - such as the aquifer at Algiers; the alluvial aquifers of Bas Sebaou; and coastal aquifers in the Annaba-Bouteldja region. Salinisation of aquifers also occurs close to saline lakes, such as at Chott.

Identified groundwater anthropogenic pollution occurs mainly in the coastal aquifers, which underlie highly urbanised areas, and where low levels of dissolved oxygen in groundwater are noted. Despite intensive farming, nitrate concentrations in groundwater generally remain below acceptable levels.

## **Groundwater-surface water interaction**

Most permanent rivers are supported by groundwater in dry periods.

There are groundwater-dependent wetlands in the region of El Tarf and Benazzouz.

# **Groundwater use and management**

## **Groundwater use**

There are a number of different estimates of groundwater abstraction for different uses in Algeria. The volume of groundwater abstracted for agriculture and industry is reviewed annually, but there is considerable uncertainty, as data are scattered and often contradictory.

One estimate of total groundwater abstraction from all sources across the country is 4.3 billion m<sup>3</sup>/year. In the northern Atlas region, the National Water Plan (Ministere des Ressources en Eau, 2010) estimated that 1.8 billion m<sup>3</sup> groundwater is used annually in total.

It is estimated that groundwater supplies 63% of total water demand in the Northern (Atlas) region, and 96% of water demand in the Southern (Sahara) region (FAO 2009).

Irrigation is the largest user of groundwater. In 2012, 69 percent of the area equipped for irrigation was intended to be irrigated by groundwater. Of this, borehole irrigation comprised 41%, wells 26% and springs 2% (FAO AQUASTAT). Irrigated agriculture provides for 40% of national agricultural production (FAO 2009).

The next largest user of groundwater is for domestic purposes.

## Groundwater sources

Estimates of the number of different groundwater abstraction sources are:

Region	Boreholes (drilled)	Wells (dug)	<i>Foggaras</i>	Managed springs
Northern (Atlas)	>12,000 (additionally possibly more than 20,000 illegally drilled boreholes)	100,000		9,000
Southern (Sahara)	>1,640		700	
All Algeria	44,615	123,099	700	9,000

Most abstraction boreholes are fitted with an electric pump.

The costs of drilling wells are highly variable. The average price for drilling a borehole is US\$200/m (FAO 2009, from information from the National Agency of Hydraulic Resources). Drilling in aquifers with simple geology can begin at US\$340/m, rising to US\$380/m for drilling in more complex geology. Depth of boreholes also affects costs. Boreholes in deep aquifers in the southern (Sahara) region are often 200 to over 1000 m deep (FAO 2009).

## Groundwater management

At a national level, the Ministry of Water Resources (MRE) is responsible for monitoring, coordination and preparation of legislation concerning the governance of groundwater.

The Agence Nationale des Ressources Hydrauliques (ANRH) is responsible for the exploration and assessment and the protection of groundwater resources. The ANRH is also responsible for groundwater monitoring (see below).

The Agence Nationale de Gestion Intégrée des Ressources en Eau (AGIRE) and the Agences des Bassins Hydrographiques (ABH) are responsible for overall water resources management. The ABH divides the country into five natural hydrographic units: Oranie-Chott Chergui; Cheliff-Zahrez; Algérois-Hodna-Soumam; Constantinois-Seybouse-Mellègue; and Sahara. These units are the focus for consultation and action on integrated water resources management.

Algerian Waters (ADE) is responsible for the exploitation of groundwater for drinking water.

The National Office for Irrigation and Drainage (ONID) is responsible for the exploitation of groundwater for irrigation.

At the regional level, groundwater management organisations include the basin committees of the five divisions of the Agences des Bassins Hydrographiques (ABH); the advisory bodies established for consultation with representatives of the State; and local authorities and users. All of these interact to discuss and formulate opinions on matters related to water at the river-basin scale.

At the local level, groundwater management organisations include the water resources directorates of the *wilayas* (departments), which are responsible in their jurisdictions for issuing drilling permits, accounting for abstracted groundwater flow rates, and monitoring and facilitating the activities of the water police.

A recent major groundwater development initiative was the 2011 Réseau de Collecte project, to transfer from 50,000 - 100,000 m<sup>3</sup>/day of groundwater from the Ain-Salah Alba aquifer in the south of Algeria to the Saharan city of Tamanrasset, over 600 km away in the central south of Algeria (FAO AQUASTAT).

The costs of abstracting water for agricultural use are below the real price of abstraction in all regions, ranging from 0.027 US\$/m<sup>3</sup> (FAO Draft synthesis report 2009) to 0.036 US\$/m<sup>3</sup> (OSS 2015).

## **Groundwater legislation**

05-12 The Law of 4 August 2005 on water covers the protection and conservation of groundwater resources by establishing:

- quantitative protection perimeters, within which new wells, drilling or modifications of existing facilities are prohibited, in order to increase the rates levied
- qualitative protection perimeters, within which all industrial activities can be regulated, prohibited, or subject to special measures of control, restriction or prohibition. These activities include in particular:
  - installation of water piping
  - tanks for and disposal of hydrocarbons
  - fuel distribution service stations
  - any industrial construction
  - waste disposal of any kind
  - manure spreading
  - disposal of any products and materials that could affect water quality.

This legislation is implemented related to the identified protection perimeters.

## **Groundwater monitoring**

The Agence Nationale des Ressources Hydrauliques (ANRH) and Agences des Bassins Hydrographiques (ABH) are responsible for groundwater quality and quantity monitoring at a national level, and for the collection, processing and updating of information on water resources.

ANRH maintains a national piezometric network monitoring groundwater. This piezometric network is comprised of 500 observation points. Piezometric measurement campaigns and analysis are done in two annual campaigns (at low and high water-level points). The data are published in tables and maps, and stored in databases of various measured and observed data: 110 000 water point files (for boreholes, wells and springs) are inventoried and archived.

ANRH also maintains a national monitoring network of groundwater quality with 550 monitoring points. These are sampled once per quarter for physico-chemical analysis, including conductivity and nitrogen elements, and twice a year for heavy metals. Water samples are sent for physico-chemical, bacteriological and hydrobiological analysis at one central or six regional laboratories, which have an annual capacity of 40,000 water samples (and 5000 soil samples). The analysed data are stored in a national water quality database, "SIQUEAU", which contains information from all water observation and measurement networks.

## **Transboundary aquifers**

The following transboundary aquifers are shared with the countries listed:

- Northern Saharan Aquifer System (SASS), also known as the North-west Sahara Aquifer System (NWSAS) : Algeria, Tunisia, Libya
- Taoudéni Basin : Algeria, Mali, Mauritania
- Air Cristalline Aquifer : Algeria, Mali, Niger
- Tin-Séririne Basin : Algeria, Niger
- Errachidia Basin : Algeria, Morocco

The NWSAS/SASS is managed through a permanent tripartite consultation mechanism hosted by the Observatoire du Sahara et du Sahel (Sahara and Sahel Observatory) (OSS). The main objective is to coordinate the joint management of water resources in the NWSAS/SASS through the continuation of work to improve understanding of the system and its exploitation. This is done through a steering committee made up of the national structures in charge of water resources in each of the three countries, which act as the national focal points; a coordination unit is managed and hosted by the OSS; and an ad hoc scientific committee is brought together for evaluation and scientific orientation.

Activities and outputs from the consultation mechanism include:

- managing and updating the tools developed by the "NWSAS" project, including the NWSAS model
- establishing and maintaining observation networks
- analysing and validating data concerning the resource
- developing databases on the socio-economic uses of water
- identifying and publishing indicators concerning the resource and its uses
- promoting and performing studies and research conducted in partnership, and
- developing and implementing training and improvement programmes.

For further general information about transboundary aquifers, please see the [Transboundary aquifers resource page](#)

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Many of the references below, and others related to the hydrogeology of Algeria, can be accessed through the [Africa Groundwater Literature Archive](#).

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